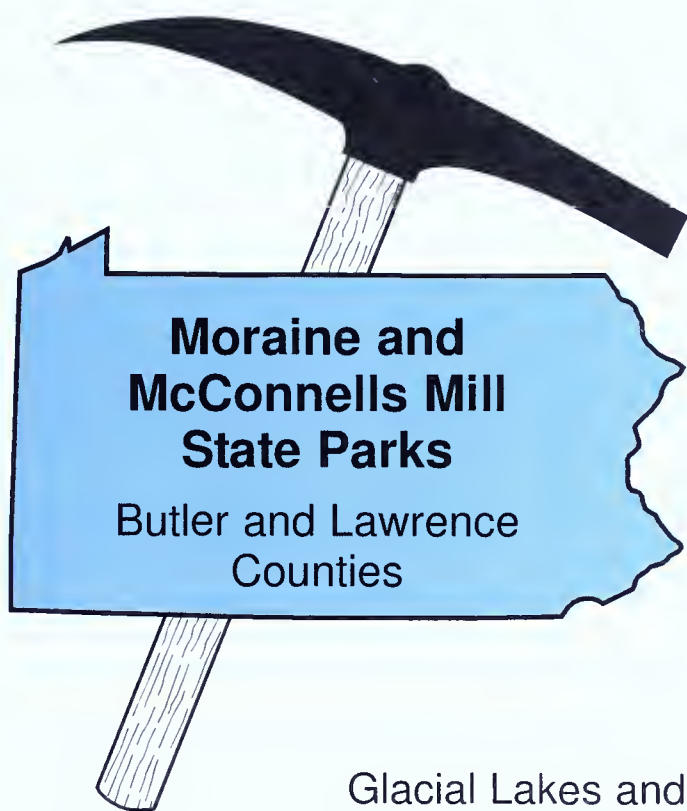


Pennsylvania

TRAIL OF GEOLOGY



Glacial Lakes and
Drainage Changes



Commonwealth of Pennsylvania
Department of Conservation and Natural Resources
Bureau of Topographic and Geologic Survey and
Bureau of State Parks

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Fleeger, G. M., Bushnell, K. O., and Watson, D. W., 2003, Moraine and Mc-Connells Mill State Parks, Butler and Lawrence Counties—Glacial lakes and drainage changes: Pennsylvania Geological Survey, 4th ser., Park Guide 4, 12 p.

Pennsylvania web site: www.state.pa.us

Department of Conservation and Natural Resources
web site: www.dcnr.state.pa.us

Bureau of Topographic and Geologic Survey
web site: www.dcnr.state.pa.us/topogeo

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CONSERVATION AND NATURAL RESOURCES

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Moraine and McConnells Mill State Parks

by

Gary M. Fleege,¹ Kent O. Bushnell,² and Donald W. Watson²

Visitors to Moraine and McConnells Mill State Parks see completely different scenes and attractions. McConnells Mill has a scenic gorge, waterfalls, rugged hiking trails, a whitewater stream, and a historic grist mill. Moraine has a large lake where visitors may go fishing, boating, or swimming, and a gentle bicycle trail. And yet this variety obscures a common geologic foundation and a similar geologic history. How and why two parks that look so different have similar, or related, geologic histories is the story of this park guide, which was originally published as two separate guides (PG 4 and PG 9).

Both parks share the same bedrock formations, and both gained their topography from the same glacial events. The bedrock formed 300 million years ago from layers of sand, mud, and peat. The topography was formed mainly during the Ice Age (approximately 2 million years ago to 23,000 years ago) as rivers diverted by the glaciers cut new channels into the land. Moraine State Park is named for the ground and end moraines deposited by the glaciers. It is somewhat of a misnomer. Little morainal topography exists within Moraine State Park because little of the park was ever covered by glaciers.

How to Use This Guide

The information in this booklet is organized in this way:

- *How the bedrock in the parks formed and the mineral resources that impacted the region—pages 2-3.
- *Glacial lakes and the formation of Slippery Rock Gorge—pages 4-5.
- *Geologic map showing the locations of features and sites of interest described in the text—pages 6-7.
- *Descriptions of specific geologic sites of interest—pages 8-13.



Look for this symbol in the guide and a similar signpost at each site to match descriptions and locations.

¹ Pennsylvania Department of Conservation and Natural Resources, Bureau of Topographic and Geologic Survey, 3240 Schoolhouse Road, Middletown, PA 17057-3534.

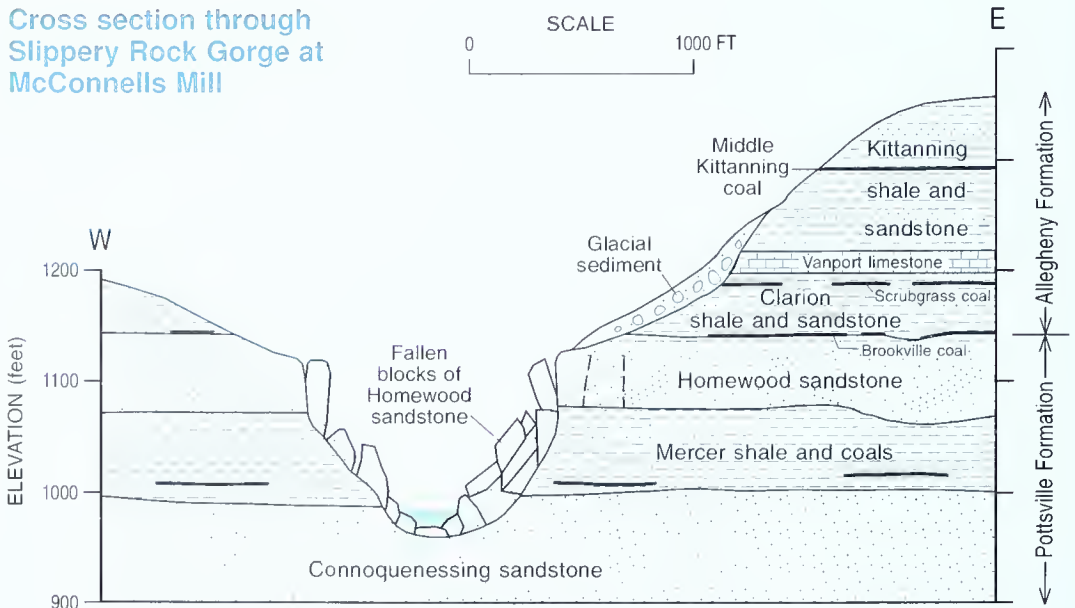
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Bedrock

The cross section below shows most of the visible bedrock in McConnells Mill and Moraine State Parks. These rocks formed during the Pennsylvanian Period of geologic history (approximately 300 million years ago), when a completely different landscape was present, and when what is now Pennsylvania was south of the equator. Rivers heavily laden with clay, sand, and gravel flowed across Pennsylvania from highlands in eastern Pennsylvania, New Jersey, and Delaware. The sediment was deposited in large deltas along the shoreline of an ancient sea that covered Ohio and western Pennsylvania. Thick layers of sand accumulated in river channels and as beaches and barrier bars along the coast. High-energy waves and currents moved some of the sand into

large ripples and dunes. Extensive swamps formed on the river floodplains and behind the beaches. In the quiet water of the swamps, layers of silt and clay and mats of thick vegetation (peat) accumulated. As the rivers changed course or the sea rose to cover the low delta areas, the sediments were buried by new sequences of peat, sand, and mud. Several times, the shallow sea rose and deposited marine clays and muds. As each layer was buried, compaction and cementation changed the soft, loose sediment to solid rock. The peat bogs and swamps became coal. The sand became Kittanning, Clarion, Homewood, and Connoquenessing sandstones, and the silts and clays formed Kittanning, Clarion, and Mercer shales. The thickest marine lime mud became Vanport limestone. As the continents moved northward

Cross section through
Slippery Rock Gorge at
McConnells Mill



about 250 million years ago, the area was uplifted, and erosion started to create the landscape as we know it today.

Mineral Resources

The early industrial economy of the region was based, in large part, on the iron, lime, oil, and coal contained within the sedimentary layers.

Vanport limestone originally was named “ferriferous limestone” for the large amount of iron mineralization in the upper part of the member. The iron ore was surface mined in the mid-1800s to feed three furnaces—the Wilroy and Hope Furnaces near Rose Point (upstream from McConnells Mill State Park) and the Lawrence Furnace in Hells Hollow (see the map on page 9). When the vast iron ore resources of the Lake Superior region became available in the 1870s, all of the local ore-mining operations and small furnaces were abandoned. The ruins of the Wilroy Furnace’s stone stack are on private property at **A** on the centerfold map, but nothing marks the sites of the other furnaces except for some glassy slag scattered on the surface of the ground. In addition to exploitation of its upper layers for iron ore, Vanport limestone itself was locally quarried and burned to produce agricultural lime.

Approximately 6½ miles south of the old gristmill, an oil seep coated

a large rock on the east bank of the stream (**B**). After oil was produced from drilled wells at Titusville in 1859, the “Slippery Rock” and other seeps along the gorge excited local drillers. By 1864, at least 17 wells had been drilled along the creek. They were shallow but yielded about 45,000 barrels of oil before groundwater invaded the sandstones and prevented further oil production. Drilling activity then shifted eastward into the Muddy Creek valley. By the 1890s, the Muddy Creek field was producing oil from formations deeper than those tapped in the Slippery Rock Gorge. The production continued in decreasing quantity into the 1930s. As production diminished, the wells were abandoned but never properly cemented and plugged. All of these wells had to be located and sealed to prevent oil seeps at the bottom of Lake Arthur, which covers much of the old Muddy Creek oil field.

Most of the minable coal is above Vanport limestone in the Kittanning Member of the Allegheny Formation. The Kittanning crops out away from the rim of the gorge and around the sides of the Muddy Creek valley. Much of this coal was mined, both by underground and strip mining, before the stringent laws regulating mine reclamation were passed in the 1960s and 1970s. Consequently, before Lake Arthur was flooded, extensive reclamation was needed to prevent lake and land pollution from mine drainage.

The Glacial Lakes and Slippery Rock Gorge

Slippery Rock Creek flows in a deep, winding gorge cut into flat-lying layers of bedrock. The gorge cuts through an old drainage divide, the remnants of a ridge that once separated streams flowing to the north from streams flowing to the south. The gorge is deepest and narrowest near Cleland Rock on the divide and becomes progressively shallower and wider both to the north and to the south. This is not a typical pattern because the valleys of streams in areas of flat-lying rocks normally become progressively shallower and wider toward their outlets.

Why does Slippery Rock Gorge have this configuration? The diagrams on this page and the next illustrate the geologic history of the gorge.

Preglacial Slippery Rock Creek was joined by Muddy Creek and flowed northwestward from near the present location of Kennedy Mill (C). From the divide at Cleland Rock, McConnells Run flowed north past McConnells Mill. Wurtemburg Run flowed south from the divide into Connoquenessing Creek, 6 miles away.

About 2 million years ago, thick masses of continental ice began to accumulate in central and northeast Canada and periodically spread southward. At least four of these advancing ice sheets, many hundreds or thousands of feet thick, reached northwestern Pennsylvania and modified the landscape and stream patterns. Not much is known



Preglacial drainage in the McConnells Mill area. Present-day locations are shown in gray.

about the effects of the first two ice sheets because most of their deposits have been eroded away.

The third known ice sheet to reach the parks moved southeastward into the area approximately 140,000 years ago and dammed the northwest-flowing Slippy Rock and Muddy Creeks. At the ice-advance maximum, separate lakes formed in the Slippy Rock Creek (Lake Edmund) and Muddy Creek (Lake Watts) lowlands. A third, much smaller lake (Lake Prouty) also formed in the McConnells Run valley, which was dammed south of Muddy Creek.

Lakes Edmund and Watts drained south through outlets at their eastern ends (D and E), far from the glacier dam, into Connoquenessing Creek. Lake Prouty spilled over a low point in the old divide near Cleland Rock (see page 11) into Wurtemburg Run.

It sufficiently eroded the old divide to form the ancestor of today's south-flowing Slippery Rock Creek.

As the glacier melted back to the northwest, Lake Watts began to drain westward through a series of temporary outlets, each lower than the preceding. The first of the outlets was Alpha Pass (**F**). After later drainage through Beta Pass (**G**), the remnant of Lake Watts was still slightly larger than the present-day Lake Arthur. Finally, Lake Watts completely drained through Gamma Pass (**H**) on the present Muddy Creek channel. When the ice receded far enough, Lake Edmund drained through Epsilon Pass, past Kennedy Mill.

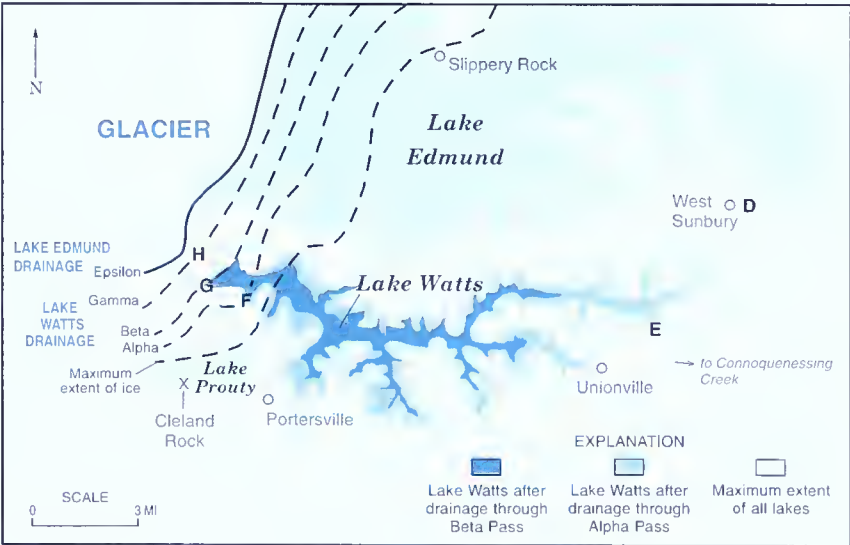
As each pass opened, a short-term flood surged into the gorge. These floods deepened the gorge and eroded soft Mercer shale beneath hard Homewood sandstone, leaving the sandstone as an overhanging cliff. Because the sandstone is cut by many intersecting cracks, unsupported large blocks fell from

the rim. Some of these large blocks moved only a few feet downslope, but others fell to the bottom of the gorge. This widened the gorge, but left it less deep than originally carved (see the cross section on page 2).

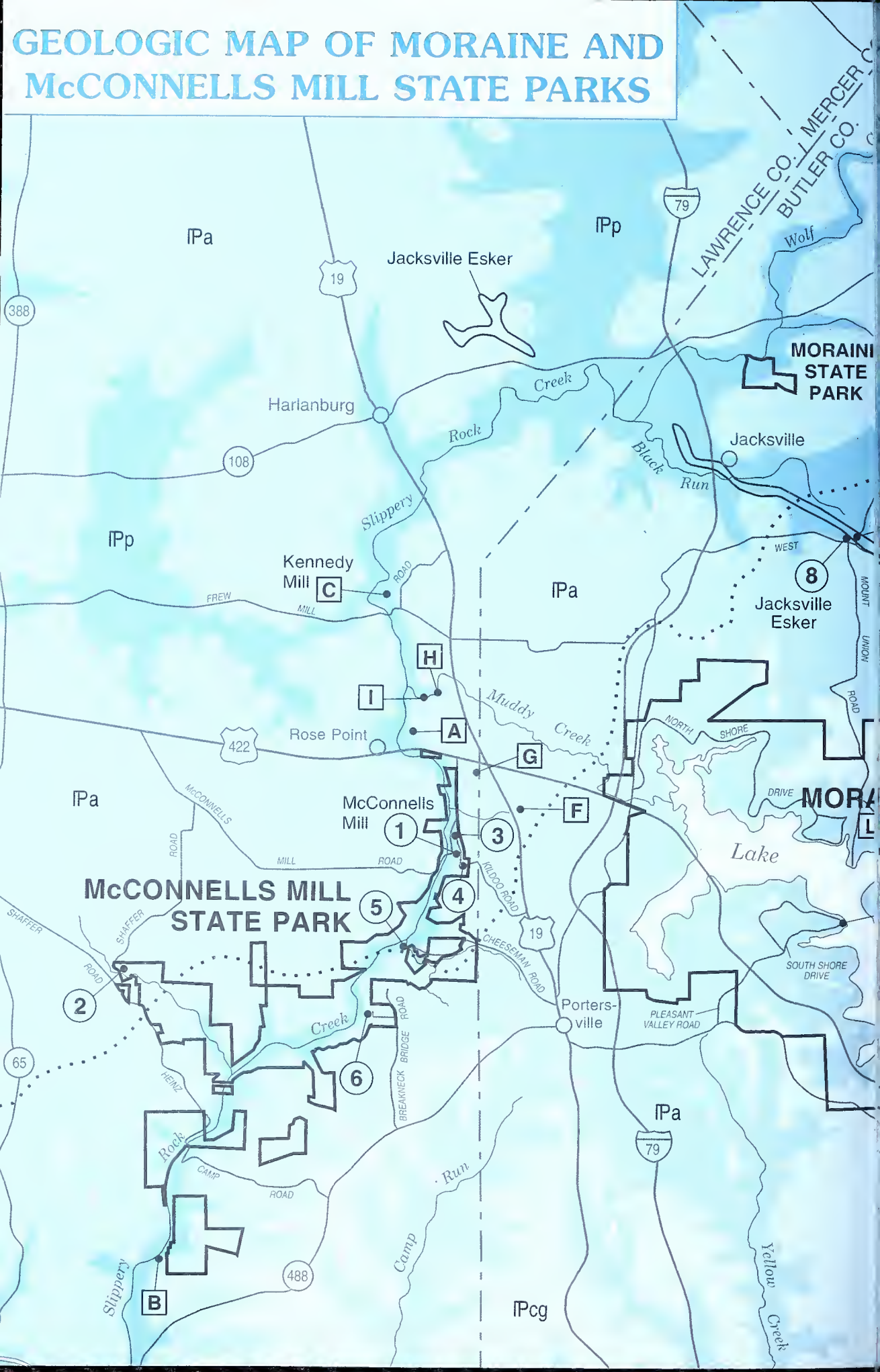
During the last glaciation to reach the area, some 23,000 years ago, ice-dammed lakes again formed in the Slippery Rock Creek and Muddy Creek basins. Drainage from these lakes further deepened and widened the Slippery Rock Gorge.

Today, Slippery Rock Creek still has a steep gradient through the gorge (28 feet per mile compared to 8 feet per mile north of Kennedy Mill). The rushing water has carved potholes in many of the large blocks of sandstone and has scoured out tubes through the remaining debris. The combination of rapids, waterfalls, and eddy currents within the channel makes for a very treacherous stream. These conditions also provided the waterpower to run both McConnells and Kennedy Mills.

Phases of glacial lake drainage during ice retreat. Present-day locations are shown in gray.



GEOLOGIC MAP OF MORAINE AND McCONNELLS MILL STATE PARKS



Geology slightly modified from Berg, T. M., Edmunds, W. E., Geyer, A. R., and others, comps., 1980, Geologic map of Pennsylvania (2nd ed.): Pennsylvania Geological Survey, 4th ser., Map 1, scale 1:250,000, 3 sheets.

EXPLANATION

IPcg

Glenshaw
Formation

IPa

Allegheny
Formation

IPp

Pottsville
Formation

Park boundary

Southeast limit of glaciation
140,000 years ago

2

Location of site
described in text

A

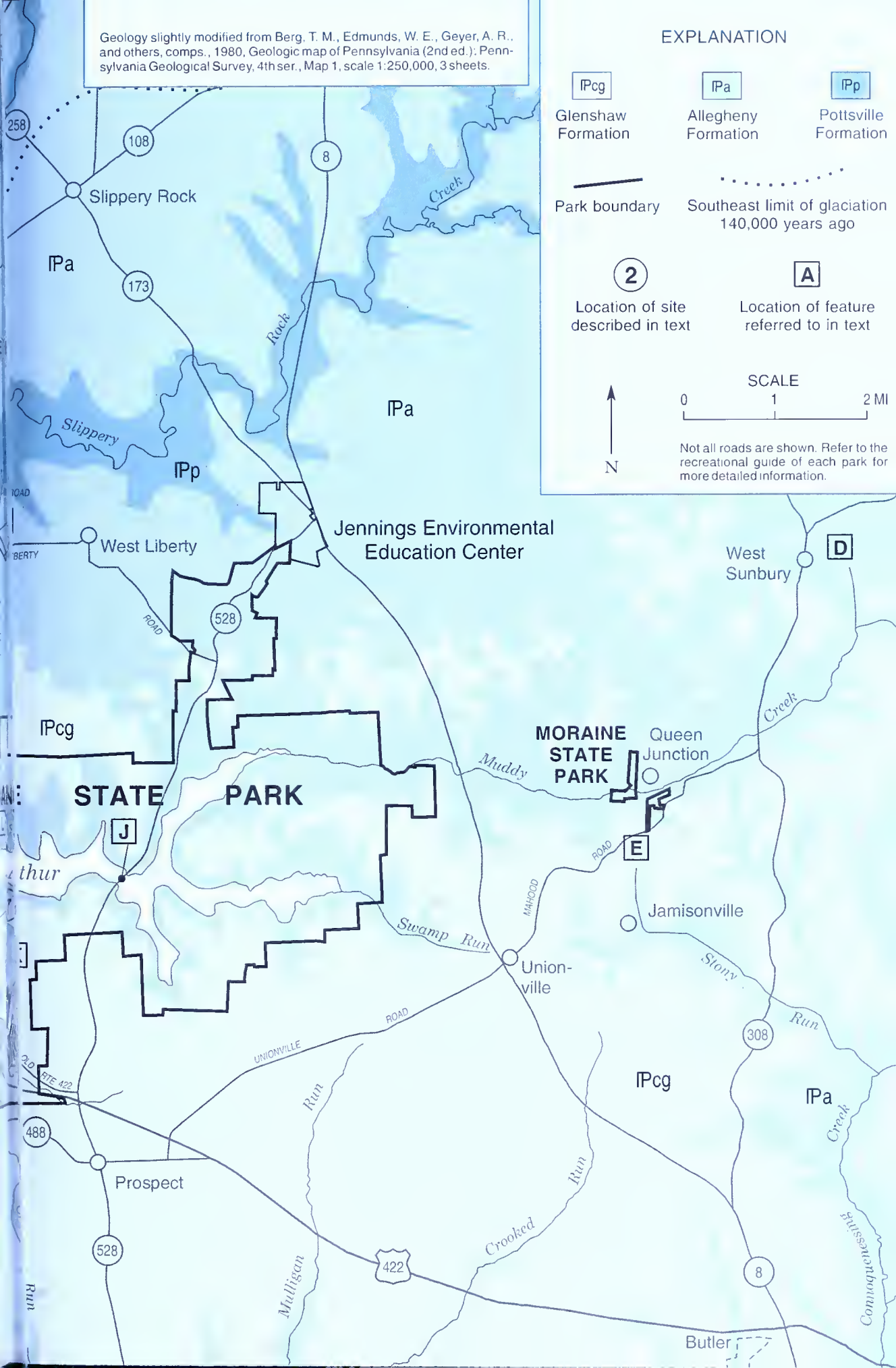
Location of feature
referred to in text



SCALE

0 1 2 MI

Not all roads are shown. Refer to the
recreational guide of each park for
more detailed information.



GEOLOGIC FEATURES IN THE PARK



Site 1. McConnells Mill Area

The trail from the picnic grounds to the mill, the road past the mill, and the trail to Alpha Falls—all cross outcrops and slump blocks of Homewood sandstone. Separation along vertical cracks (center of the rock city photograph), downslope rotation of some blocks (left side of the rock city photograph), and cross-bedding and pebbly composition in some layers are visible features of the sandstone. A honeycomb pattern has also formed on a few weathered surfaces (see the photograph below). This forms because groundwater moving through the rock deposits iron minerals that are more resistant to weathering than the surrounding rock. The iron-rich sandstone layers stand out when the rock is weathered.

At the Rim Road Climbing Area, large blocks of Homewood sandstone have separated from the outcrop and slumped downslope to create open walkways and a spec-



Honeycomb weathering

tacular “rock city.” The north exit road from the mill (McConnells Mill Road) passes through a similar rock city.

The intact ledges at the mill dam are at the top of Connoquenessing sandstone, about 40 feet below Homewood sandstone and directly beneath Mercer shales and coals (see the cross section on page 2).



Rock city along the exit road



Site 2. Hells Hollow

A short hike along Hells Hollow Trail toward Hells Hollow Falls takes you past a number of features related to Vanport limestone and the old iron industry that flourished in the valley of Slippery Rock Creek during the mid-1800s (see the map on page 9).

In the streambed adjacent to the parking lot, sharp, distinct fractures cut through Vanport limestone. During dry periods, no water flows in the stream here, but water does flow in a small cave formed by dissolution of the limestone.

The Lawrence Iron Furnace was a few hundred feet upstream from the third bridge on Hells Hollow Trail.



Fractured Vanport limestone



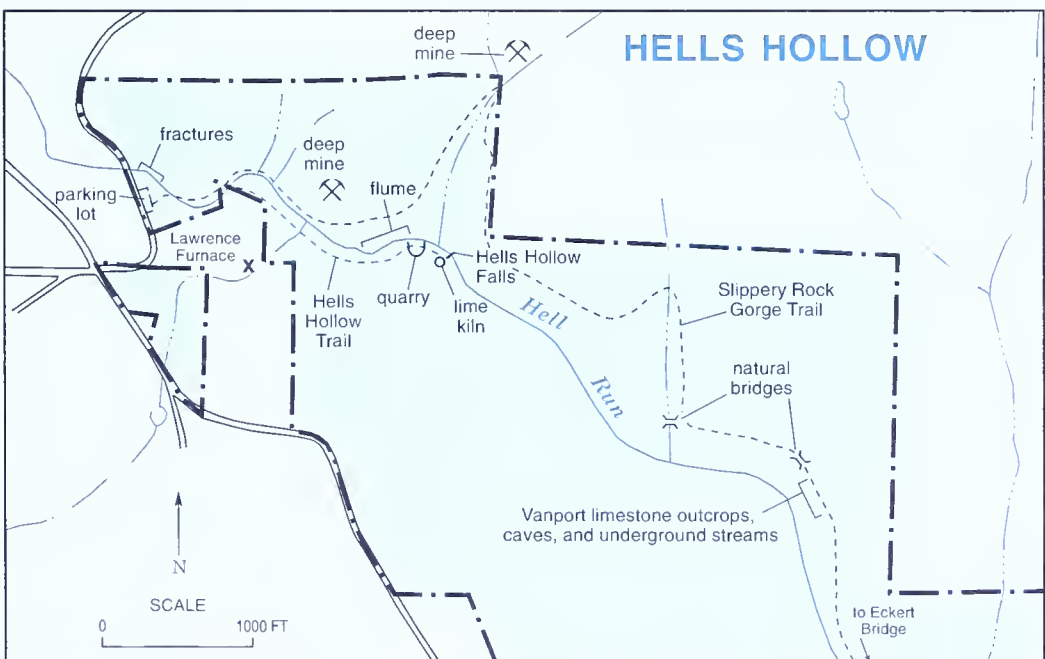
Flume

From the far side of the third bridge, you might see an entrance to a small, long-abandoned (over 100 years) coal mine. The entrance is hidden by foliage high on the hillside across Hell Run.

Further along the trail toward the falls, Hell Run flows in a narrow flume that was originally a limestone cave. With time, the roof of the cave collapsed and exposed the hidden channel. Small depressions beside this section of the trail are

sinkholes, also formed by limestone dissolution.

Just upstream from the falls is a small quarry where iron ore and limestone (used for flux) were probably mined for the Lawrence Furnace. Shortly beyond this, the trail ends at Hells Hollow Falls, a picturesque cascade over resistant Clarion sandstone. Vanport limestone is visible here as ledges along the gorge walls. To the right of the end





Hells Hollow Falls

of the trail is a brick-lined vertical shaft cut into the rock. This is a lime kiln that was used to burn limestone, probably from the quarry, to produce lime.

A longer and more rugged trail, Slippery Rock Gorge Trail, follows the north side of Hells Hollow. It also has geologic features, including old coal mine entrances, Vanport limestone outcrops, natural limestone bridges, small caves, and emerging underground streams.

Sites 3, 4, and 5.



Alpha, Kildoo, and Breakneck Falls

Waterfalls of two origins are common features along the gorge. Small, low falls, such as Hells Hollow Falls, form where a stream in its normal course flows across hard rock layers (sandstone and limestone) that do not erode as easily as weaker layers (shale and siltstone). This type of falls is the most common and can be found on almost every tributary to Slippery Rock Creek. The rapids in Slippery Rock Creek are situated on reaches of

the stream where resistant sandstone blocks are particularly large and numerous in the rubble that fills the gorge.

More spectacular, high falls occur on the east side of the gorge. At Alpha, Kildoo, and Breakneck Falls (Sites 3, 4, and 5, respectively), tributaries to Slippery Rock Creek flow across resistant Homewood sandstone and plunge into the much deeper Slippery Rock Gorge. Be-

Alpha Falls



Breakneck Falls

cause the smaller streams could not erode downward as fast as the main stream, they enter Slippery Rock Creek as “hanging waterfalls.” In the case of Alpha Falls and Muddy Creek Falls (I), the streams that form the cascades were outlets for Lake Watts as the ice retreated northward and exposed low spots along the western side of the glacial lake. For a short time, water from Lake Watts poured over these lips into the gorge, flushing glacial debris and undercutting the sandstone rim on each occasion.



Site 6. Cleland Rock

Cleland Rock is a ledge of Kittanning sandstone that forms a scenic overlook 400 feet above the deepest part of the 12-mile-long Slippery Rock Gorge. It is also the highest elevation along the rim of the gorge.

Approximately 140,000 years ago, a ridge extended across what is now the Slippery Rock Valley. The ridge separated the south-flowing Wurtemburg Run from Lake Prouty, which lay in the McConnells Run valley to the north of this divide (see the sketch of Lake Prouty).

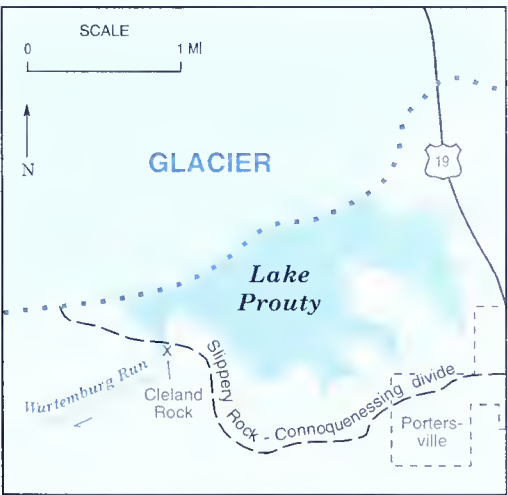
Overflow from Lake Prouty, assisted by meltwater and sediment released from the nearby glacier, spilled over the divide at Cleland Rock into Wurtemburg Run. This overflow eventually eroded a channel through the divide at Cleland Rock deep enough to join McConnells Run and Wurtemburg Run. Together these streams formed the ancestral



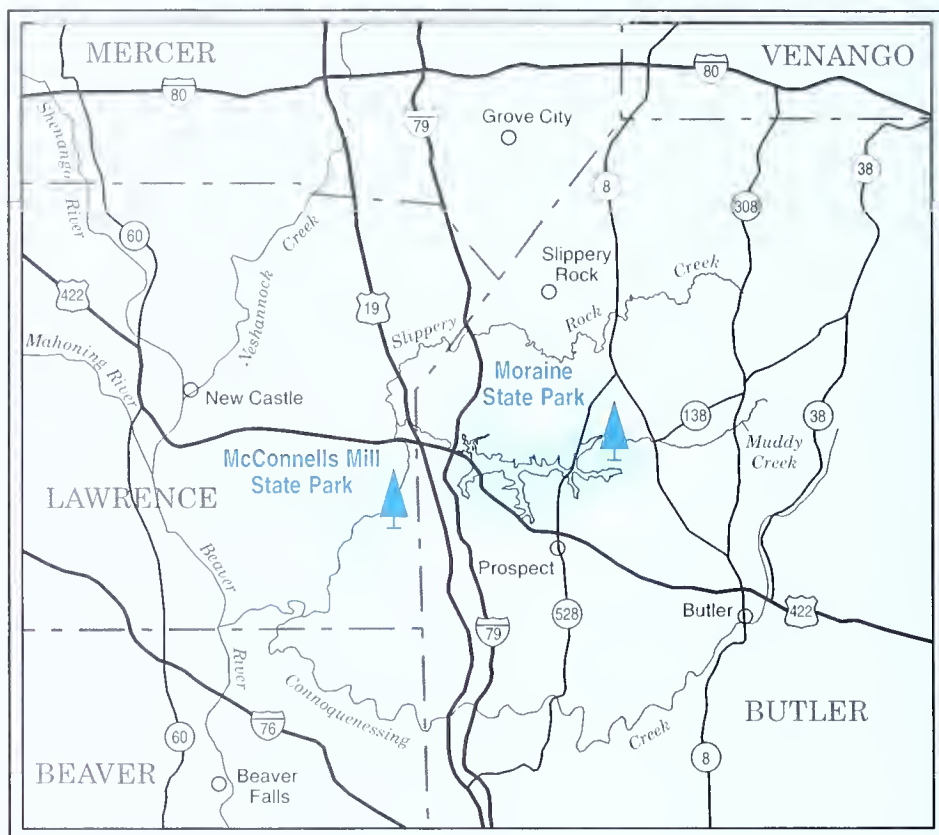
Cleland Rock

south-flowing Slippery Rock Creek and drained Lake Prouty.

After Lake Prouty drained, the newly created Slippery Rock Gorge was probably no more than half of its present depth. During the last two glaciations (140,000 and 23,000 years ago), catastrophic flooding from the draining of glacial Lake Watts and Lake Edmund caused the gorge to erode to greater than its present depth. Rocks that have fallen into the gorge from the adjacent slopes have reduced the depth of the gorge.



Lake Prouty overflow



**For more information on either park,
contact**

Moraine State Park
225 Pleasant Valley Road
Portersville, PA 16051-9650
724-368-8811

